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IDENTIFICATION OF COMBINERS IN *RABI* SORGHUM INVOLVING DIVERSE CYTOSTERILES

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ABSTRACT

Present study comprised of line x tester analysis involving 6 male sterile lines of three diverse cytoplasmic backgrounds (A_1, A_2 and A_4) and 4 testers for combining ability studies. Analysis of variance revealed the presence of significant differences due to lines, testers and line x tester, indicating the presence of variability. For grain yield/plant, A_2 cytosterile 20A and tester AKR492 were good general combiners. A_2 cytosterile: 20A and A_4 cytosterile: M-31-2A along with tester 2043 were good general combiners for fodder yield/plant. A1 cytosterile 1409A and tester AKR492 were identified as good general combiners for plant vigour. Female parent 20A (A_2) and male parent AKR492 appeared to be best general combiners for yield and yield attributing traits, could be used in further sorghum breeding programme for developing high yielding *rabi* sorghum hybrids. The cross combinations 9A x AKR492, 25625A x 2043, 1409A x 4109, 104A x 10515 and M-31A x 4109 exhibited significantly high SCA effect for fodder yield/ plant. The hybrids based on diverse cytoplasms *viz*., 9A x 4109, 25625A x 2043, 104A x 10515 and 1409A x AKR492 exhibiting significant SCA effect in desirable direction for grain yield/ plant which may be tested in multilocation trials for their stability.

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INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major crops for grain and fodder, which is widely grown in India under rainfed conditions. The yield levels of *rabi* sorghum are low as compared to the *kharif* sorghum. Therefore, there is need for critical studies in *rabi* sorghum for heterosis and combining ability involving diverse germplasm. Developing high yielding post rainy season adapted varieties/ hybrids is the main objective in almost all the crop improvement programmes. (Kalpande *et al*. 2015). Selection of parents on the basis of phenotypic performance alone is not a sound procedure since phenotypically superior line may yield poor recombination. It is therefore, essential that parents should be chosen on the basis of their genetic value (Krupkar *et. al*. 2013).

The estimates of combining ability are useful to predict the relative performance of different lines in hybrid combinations. Combining ability also provides necessary information on nature and magnitude of gene action which is important in understanding genetic potential of population. The line x tester mating design help in assessing the combining ability of parents there by selection of superior parents as well as cross combinations (Sprague and Tatum, 1942). The extensive use of single source of genetic male sterility had raised the fear of occurrence of its potential vulnerability to pests and diseases as during 1970's (Lakshmana *et. al.,* 2010).The work on diverse cytoplasm i.e. *milo* and non-*milo* cytoplasms have been reported by Kishan and Borikar (1988) and Reddy *et.al*. (2007). Thus present study was carried out to study combining ability, with special emphasis on yield and yield parameters using diverse cytoplasm based male sterile lines.

MATERIALS AND METHODS

The experimental material for study consisted of six diverse cytoplasm based male sterile lines *viz*., 104A, 1409A (A_1 cytosterile), M-31-2A, 9A (A_4 cytosterile) and 20A x 25625A (A_2 cytosterile) and four restorers *viz*., 2043, 10515, AKR492 and 4109. Which were crossed in line x tester fashion (Kempthorne, 1957) to obtain 24 hybrids during post rainy season 2013-14. These 24 hybrids along with 10 parents and 2 checks CSH-18 and M-35-1 were grown in randomized block design (Panse and Sukhatme, 1967) with two replications in post rainy season 2014-15 at Sorghum Research Station, VNMKV, Parbhani (MS). Each replication was divided in to two tiers to reduce soil heterogeneity. Each genotype planted in two rows with row length 4m and spacing 45cm x 15cm. Observations were recorded for plant vigour, shootfly damage %, number of leaves, leaf length, leaf width, chlorophyll content (%) of flag leaf & chlorophyll content (%) of third leaf at 50% flowering, relative water content % at 50% flowering, grain yield/plant and fodder yield/plant.

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) indicated that, highly

Table1: Analysis of variance

Source	d.f.	Plant vigour	Shootfly damage %	No. of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Chlorophyll content at 50% flowring (flag leaf)	Chlorophyll content at 50% flowring (third leaf)	Relative Water content %	Grain yield/plant (gm)	Fodder yield/plant (gm)
Replications	1	0.05	0.18	0.08	0.15	0.86	1.01	11.24	0.00	2.39	8.61
Genotypes	33	0.94**	153.25**	1.48*	43.61**	0.86**	36.32**	33.47**	298.34**	482.52**	2023.04**
Line	5	0.53**	225.25*	2.41**	18.27	1.40**	19.17	30.32*	205.37**	667.04**	986.25**
Tester	3	0.50**	144.04**	1.87**	69.83*	1.23**	60.61**	70.65**	38.03	219.39**	547.76**
Line × Tester	1	0.83**	919.09**	2.82*	55.33	1.12*	0.25	51.77*	388.48**	157.67*	198.66**
Error		0.06	4.37	0.42	16.24	0.26	9.16	9.88	40.45	25.84	20.53

Table 2: General c ombining ability effects (GCA) for yield and yield parameters.

Genotypes	Plant vigour	Shootfly damage %	No. of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Chlorophyll content at 50% flowering (flag leaf)	Chlorophyll content at 50% flowering (third leaf	Relative Water content %	Grain yield/plant (gm)	Fodder yield/plant (gm)
Lines										
104A	-0.63**	1.85	-0.80	0.40	0.06	-0.81**	-2.12**	6.00	1.76	-20.20**
1409A	0.63**	3.63*	-0.40**	6.24	0.48**	5.10*	3.97	-0.68**	6.50	-4.97**
9A	-0.25**	-2.45**	0.41*	-3.11**	-0.05**	-2.59**	-1.49**	-6.55**	-1.66**	3.80
M-31 2A	0.32	-4.67**	0.13	-1.71**	-0.15**	-1.35**	-0.68**	-4.29**	-9.36**	31.53**
20A	0.25**	-2.37**	0.20	-0.97**	-0.20**	1.41	2.43	5.51	15.13*	21.30**
25625A	0.36	4.02*	0.45**	-0.85**	-0.14**	-1.77**	-2.10**	0.02	-12.37**	-31.47**
SE ±	0.09	0.74	0.23	1.43	0.18	1.07	1.11	2.25	1.80	1.60
Tester										
4109	0.17**	-0.67**	-0.004**	-2.42**	-0.47**	-0.65**	0.04	-10.78**	-7.05**	-1.34**
2043	-0.17**	-3.43**	0.20*	-0.39**	0.14*	-1.00**	-1.03**	8.67	-10.26**	31.01**
10515	-0.17**	3.94**	0.31**	1.60	0.09	-0.64**	-1.10**	-3.60**	4.26	-13.45**
AKR 492	0.17**	0.15	-0.50**	1.21	0.24**	2.29	2.09	5.71	13.05*	-16.22**
SE±		0.60	0.19	1.16	0.15	0.87	0.91	1.84	1.47	1.31

significant variation due to line was for plant vigour, shootfly damage %, number of leaves, leaf width, relative water content at 50% flowering, chlorophyll content of third leaf at 50% flowering, grain yield/plant and fodder yield/plant. As regard to testers, significant differences observed for all the traits studied except relative water content at 50% flowering. The variances due to line x tester were also highly significant for all the traits except leaf length and chlorophyll content of flag leaf at 50% flowering

It is evident from the study that, the estimates of variances for SCA were higher in magnitude than GCA variances for all the traits studied except leaf length, grain yield and fodder yield indicating preponderance of non-additive gene action. Whereas, GCA variances were higher than SCA variances for leaf length, grain yield and fodder yield indicating preponderance of additive gene action for these traits.

GCA effects (Table 2) reflect true genotypic value of a line, as these are estimated as mean effect of a line in a series of crosses (Reddy *et al.*, 2007). *Per se* performances of the parents with high GCA provide criteria for choice of the parents for hybridization and they are desirable for obtaining useful segregants in early generations (Jain and Patel 2014). Estimation of GCA effects indicated that A_1 cytosterile 1409A was good general combiners for plant vigour along with tester AKR492. As regard to shootfly damage %, A_2 cytosterile 25625A and A_1 cytosterile 1409A were good general combiners along with tester AKR492 but similar result was not showed by A_2 cytosterile 20A and A_1 cytosterile 104A. A_4 cytosterile 9A, A_2 cytosterile 25625A along with testers 10515 and 2043 were identified as good general combiners for number of leaves. Similarly, Bhavsar and Borikar (2002) also reported A_2 and *maldandi* (A_4) based male sterile lines as good general combiners for number of leaves per plant. None of the parent showed significant positive GCA effect for leaf length, relative water content and chlorophyll content at 50% flowering. As regard to leaf width, A_1 cytosterile 1409A and restorers AKR492 and 2043 were observed to have significant positive GCA effect. Similarly, Girma *et al.* (2010) also observed significant positive GCA effect for leaf width. A_2 cytoplasmic male sterile line 20A and tester AKR492 were best general combiners for grain yield/plant but similar result was not showed by iso-cytosterile 25625A. Murumkar *et al.* (2005), Prabhakar and Raut (2010) and Ghorade *et al.* (2014) also reported promising general combiners for grain yield and from their studies. The data fairly showed that the GCA effect exhibited by iso-cytosterile lines was not uniform for all the characters.

Specific combining ability results (Table 3) is indicative of heterosis. For plant vigour five cross combinations showed significant positive SCA effect. The cross 25625A x AKR492 exhibited highest significant positive effect followed by 9A x 2043, M-31-2A x 4109, 1409A x AKR492 and M-31-2A x 10515. Out of twenty four, seven cross combinations exhibited significant positive SCA effect for shootfly damage % from which, cross combination 20A x AKR492 rank I in SCA effect followed by M-31-2A x AKR492 and 20A x 2043 for shootfly damage%. As regard to number of leaves, cross combinations 20A x AKR492, 9A x 10515 and 1409A x AKR492 exhibited significant positive SCA effect (Murumkar *et al.*, 2005 and

Table 3: Specific combining ability effect (SCA) for yield and yield parameters.

Sr. no.	Genotypes	Plant vigour	Shootfly damage%	No. of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Chlorophyll content (flag leaf)	Chlorophyll content (third leaf	Relative Water content %	Grain yield/plant (gm)	Fodder yield/plant (gm)
1	104A x 4109	0.21	5.60**	0.48	-1.03	0.10	-4.17	-2.12	7.71	5.93	-16.14**
2	104A x 2043	0.04	-5.30**	-0.22	-3.67	-0.40	0.63	-2.15	-7.99	-14.43**	-2.99
3	104A x 10515	0.04	5.78**	-0.44	2.73	-0.10	4.67*	3.81	1.78	12.65**	15.88**
4	104Ax AKR 492	-0.29	-6.08**	0.18	1.96	0.41	-1.14	0.46	-1.50	-4.15	3.25
5	1409A x 4109	-0.04	-6.14**	0.08	1.24	-0.11	-3.50	-2.84	4.93	-14.75**	17.14**
6	1409A x 2043	-0.21	-3.84*	0.48	-0.53	0.08	1.65	2.91	1.51	2.34	-6.41
7	1409A x 10515	-0.21	7.15**	-0.64	-1.89	-0.39	3.03	2.15	-12.57*	1.05	-1.85
8	1409A x AKR492	0.46*	2.83	0.08*	1.17	0.42	-1.18	-2.22	6.13	11.36**	-8.88*
9	9A x 4109	-0.67**	1.51	-0.02	-0.81	-0.26	0.94	0.59	-28.47**	15.17**	-20.14**
10	9A x 2043	0.67**	5.31**	-0.02	3.78	0.51	-1.50	-2.92	10.24*	2.95	-2.39
11	9A x 10515	0.17	-3.01	1.06*	0.70	0.68	-4.07	-1.32	11.43*	-11.81**	1.18
12	9A x AKR492	-0.17	-3.81*	-1.02*	-3.68	-0.92*	4.64*	3.65	6.80	-6.31	21.35**
13	M-31 2A x4109	0.58**	-6.73**	-0.35	-2.44	-0.50	1.16	2.33	-4.03	-3.87	12.44**
14	M-31 2A x 2043	-0.08	2.28	0.15	-2.20	0.10	2.42	3.77	-4.56	-5.33	-1.31
15	M-31 2A x 10515	0.42*	-6.37**	0.44	-1.60	-0.35	-5.07*	-5.43*	13.96**	4.18	-3.25
16	M-31 2A x AKR492	-0.92**	10.82**	-0.45	6.24*	0.75	1.49	-0.67	-5.36	5.01	-7.88*
17	20A x 4109	0.33	-5.45**	-0.42	1.96	0.18	1.27	-1.49	10.76*	-3.21	4.36
18	20A x 2043	-0.33	7.96**	-0.02	1.12	-0.41	1.21	2.28	-0.77	1.35	-5.59
19	20A x 10515	0.17	1.04	-0.64	-3.01	0.29	0.49	0.79	-2.18	-1.19	-3.62
20	20A x AKR492	-0.17	-3.55*	1.08*	-0.07	-0.06	-2.97	-1.57	-7.81	3.05	4.85
21	25625A x 4109	-0.42*	11.22**	0.23	1.07	0.58	4.31	3.53	9.11	0.72	2.34
22	25625A x 2043	-0.08	-6.41**	-0.37	1.49	0.13	-4.41	-3.88	1.57	13.12**	18.69**
23	25625A x 10515	-0.58**	-4.60**	0.21	3.07	-0.12	0.95	0.00	-12.42*	-4.88	-8.35*
24	25625A x AKR492	1.08**	-0.21	-0.07	-5.63	-0.58	-0.85	0.35	1.74	-8.96*	-12.68**
	SE ±	0.17	1.48	0.46	2.85	0.36	2.14	2.22	4.50	3.59	3.20

Pattanshetti *et al*., 2005). For leaf length, M-31-2A x AKR492 identified as best specific combiner. None of the cross combination showed significant positive SCA effect for leaf width. None of the cross combination exhibited significant positive SCA effect for chlorophyll content at 50% flowering of third leaf. The crosses 104A x 10515 and 9A x AKR492 showed significant SCA effects in desirable direction for chlorophyll content at 50% flowering of flag leaf . Four cross combinations including, A_2 cytosterile based hybrid 20A x 4109 and three A_4 cytosterile based hybrids *viz.,* M-31-2A x 10515, 9A x 10515 and 9A x 2043 exhibited significant SCA effects in desirable direction. Similarly, Minal Goyal (2013) also observed significant positive SCA effects for relative waster content at 50% flowering. For fodder yield/plant, five crosses showed significant positive SCA effects, from which the cross 9A x AKR492 exhibited highest significant SCA effects in desirable direction followed by cross combinations 25625A x 2043, 1409A x 4109, 104A x 10515 and M-31A x 4109. As regard to grain yield/plant, four hybrids out of twenty four showed significant SCA effects in desirable direction in which 9A x 4109 rank I followed by 25625A x 2043, 104A x 10515 and 1409A x AKR492.

From present study it is reflected that parental line 20A (A_2) among females; AKR492 among males and combinations 9A x 4109, 25625A x 2043, 104A x 10515 and 1409A x AKR492 could be exploited in future *rabi* sorghum breeding programme by adopting appropriate breeding approach in order to develop high yielding *rabi* sorghum hybrids.

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